WARE POTATO STORAGE PROTOCOLS AND GUIDELINES FOR KENYAN SMALLHOLDERS

National Potato Council of Kenya (NPCK)

CNFA Farmer to Farmer Program

Joseph Guenthner
University of Idaho

Kenya

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Introduction

This document was developed by me -- Dr Joseph Guenthner -- during a US AID Farmer-to-Farmer (FTF) project in Kenya in December 2012. The National Potato Council of Kenya (NPCK) requested an FTF volunteer through CNFA, the administrative organization for FTF in Kenya, Wachira Kaguongo, CEO of NPCK served as the Project Host. Nyambura Theuri, Country Director of CNFA, developed the Scope of Work. The focus of the project was on ware potato storage for small farmers in Kenya.

Objectives

The project objectives were to:

1. Improve the quality of stored potatoes, and enhance trust between traders, processors, farmers and financiers.
2. Decrease post-harvest losses and improve the shelf-life of potatoes
3. Stabilize seasonal fluctuations in potato availability and regulate price fluctuations.

These are long-run goals that could not be accomplished during the time I was in Kenya. They are worthy goals for the future. Improved storage could increase grower profits while providing a steady, year-round supply of high-quality potatoes to consumers.

Deliverables

The Scope of Work lists the following Deliverables:

1. Ware potato storage protocols and guidelines for Kenyan smallholders
2. Future volunteer training
3. Assignment related photos
4. Trip report, TBR and TER

This manuscript addresses the request for Deliverable #1. It could serve as a resource for volunteers in the future (Deliverable #2). The other two deliverables are submitted separately. An additional delivered product is the PowerPoint file from the oral presentation made at NPCK near the end of the project.

Meetings

Wachira Kaguongo and Nyambura Theuri developed a schedule of meetings for the me to meet with potato growers and experts. Organizations represented by the experts included the International Potato Center (CIP), Kenya Agricultural Research Institute (KARI), Ministry of Agriculture (MOA), Smallholder Horticultural Marketing Program (SHOMAP) and the Agricultural Development Corporation (ADC).

Also included in the itinerary were a Potato Field Day at Kasima Farms and meetings with groups of potato farmers. Many of the growers were officers of

local farmer groups and cooperatives. Grower meetings were mostly on farms in the following areas or near the following towns: Njabini, Kasima, Meru, Murangaru, Navaisha, Bomet and Molo

Potato Storage Background

Potato storage concepts were discussed during potato grower meetings. Growers shared what they knew about storage in their areas and were eager to learn more. The I was in a learning mode to evaluate current practices and in a teaching mode to share his knowledge with growers.

Living Plant Material

The first concept is that potatoes are alive. Potato tubers are living plant tissue that is genetically programmed to facilitate the survival of the species. They continually respire, taking in oxygen and giving off carbon dioxide. Harvested potatoes will sprout and try to grow into the next generation of potato plants. For ware potato storage, sprouting is the natural physiological process that must be slowed.

Storage Risks

Sprouts are one problem that makes potatoes undesirable in the market. Another is a loss of water weight that makes the tubers soft and flabby. Storage growers store face the risk of both quality loss and quantity loss as potatoes lose weight and some spoil. There is also the risk of losing money on the storage operation.

Controls

Ware potato storage is more likely to be profitable for growers who can control all or most of the following:

1. Harvest-time quality
2. Light
3. Temperature
4. Humidity
5. Air flow

Many of the recommendations in this project focus on the first factor. Storage potatoes require more management care than those headed to market at harvest. Storage should be dark to prevent greening of tuber from light. Temperatures should be kept consistently cool. Potatoes may be stored for ten months or longer if temperatures can be held in the range of 2°C to 4°C. That length of storage is not needed in Kenya where two crop per year are grown. Humid air flowing around the tubers is also important for even short-term storage.

Principles

I developed a set of three principles for potato storage:

1. Put only the best-quality potatoes into storage
2. Keep the living organisms (tubers) happy
3. Quality is a one-way street

The recommended practices revolve around those principles. The third item means that potato storage cannot enhance potato quality. It can only slow the deterioration of the tubers.

Types of Storage

Ware potatoes are stored under these methods:

1. ***In Field***: leave potatoes in the rows where planted
2. ***Clamp***: put potatoes in a hole in the ground or in covered piles
3. ***Multi-purpose***: use existing building for short-term storage
4. ***Ambient***: use cool, moist outside night air to enhance storage conditions
5. ***Powered***: use fans to force air into stored potatoes
6. ***Cold Storage***: use refrigeration to optimize temperature

I asked growers about In-Field storage. Most used it to some degree while deciding the best time to sell potatoes. Few saw it as any more than a very short term storage method because of disadvantages listed in Table 1. Some growers had tried small-scale clamp storages but there were concerns about security, water damage and pest infestation.

KARI researcher Nancy Ng'ang'a found that growers currently use a variety of potato storage types (Table 2). Although she used different categories than I did, some things are clear. First nearly half the growers in both Nyandarua and Meru Counties used dark storage. That provides protection from greening. More than one-fourth of the growers in both counties used lighted stores with potatoes in sacks. That method provides less protection.

Recommendations

My ware potato storage recommendations are for small farmers. Since I assumed my guidelines were to be developed for on-farm storage, the Cold Storage method is unlikely to be used. The following recommendations focus on the Ambient storage method for two reasons. First, it would likely provide what is needed to store ware potatoes during the dry season, or up to three months. Second, although it requires a significant up-front investment it does not require access to power.

Pre Plant

The first decision for growers who want to store potatoes should be made before the crop is planted. Included among those decisions are:

1. *Select variety*. Some potatoes store better than others. In other countries where long-term storage is practiced, some early-harvested varieties are unsuitable for storage. I learned that Sangi is an early maturing variety that breaks dormancy rapidly. It is likely not a good storage variety.
2. *Select field*. Since only the best potatoes should be stored, the crop intended for storage should be planted on the best land. The soil should be fertile and well drained. Low spots in wet fields can cause storage problems.
3. *Consdier transport*. Growers should also consider the field location regarding distance from the storage. Long transport on rough roads could cause tuber damage.

Planting

Important decisions must also be made regarding timing of planting and the type of seed that will be planted. Decisions include:

1. *Seed quality*. Top seed quality helps produce the right quality crop for storage. Growers should plant certified or clean seed for their storage potatoes to reduce the incidence of diseased potatoes that go into storage.
2. *Seed size and spacing*. Seed size influences the quality of the crop. I heard growers talk about egg-sized seed giving the best results. Seed spacing should also be considered. Grower experience is a valuable resource for this decision.
3. *Plant last*. Growers store potatoes to extend the marketing window as long as possible into the dry season. The storage potatoes should be planted so they mature late and go into storage at the end of the rainy season. Dry soil will not harm a potato crop that is mature.

Pre Harvest

The end of the growing season is a critical time for storage potatoes.

1. *Dehaulming*. The potato plant growth above the soil must be killed to prepare the tubers for storage. Some growers I met practiced

dehaulming. Some pulled the potato vines up, while keeping one hand around the base of the plant to prevent tuber lifting. Others cut the plants at the soil level. KARI research showed that growers practicing dehaulming ranged from 7% in Kiambu County to 28% in Meru County (Table 3).

2. *Skin set*. The purpose of dehaulming is to prepare potatoes for storage. Growers should wait one to two weeks after dehaulming to allow time for potato skins to "set" or become tougher and thicker. This reduces the amount of damage during handling. Delay harvest if tuber skin does not seem tough enough.
3. *Protect tubers*. Since the storage potatoes are the most valuable crop on most potato farms, extra care should be taken to protect them. Some growers told me about damage caused by porcupines and other animals.

Harvest

After the skin has set following dehaulming growers can begin harvest. My recommendations for harvest include:

1. *Last harvested*. The same rationale for making the storage potatoes the last planted points to making them the last planted. The purpose of storage is to extend market opportunities into the dry season.
2. *Clean potatoes*. Storage potatoes should not be harvested during wet conditions. The problem with muddy potatoes going into storage is that air flow is impeded.
3. *Temperature*. Potatoes that are harvested during cold and hot weather can cause storage problems. Since frost is not a concern in Kenya the too-cold situation does not apply. If extremely hot weather occurs, growers should avoid harvesting during the hottest time of the day.

Handling

Handling of the potatoes between the field and storage is also important:

1. *Avoid rain, wind and sun*. Rained on tubers do not store well. If it looks like rain is coming avoid having potatoes exposes. The same goes for leaving harvested potatoes exposed to excessive sunlight or wind.
2. *Handle like eggs*. Potato skins have been set with dehaulming and are able to withstand some slight scuffing and dropping, but any injuries during handling can cause storage problems. Workers who handle the potatoes should be advised to handle them like eggs.
3. *Sorting*. Diseased and severely damaged tubers should not enter the storage. They can casue the rot of potatoes around them. In some potato markets can get premiums for potatoes sorted by size. If those market opportunities arise, soring before the potatoes go into storage provide efficiency and flexibility.

Storage Preparation

The potato storage facility needs to be ready for the storage season.

1. *Maintenance and repair*. Before the potatoes go into the storage the growers should have repaired leaky roofs, doors and walls.
2. *Clean*. The storage floor should be swept clean of any plant debris, especially old-crop potatoes. These plant materials could be sources of disease that could damage potatoes in storage.
3. *Disinfect*. After cleaning out debris, growers should spray a disinfectant on floors, walls and any tools or equipment that potatoes will touch.

Curing

The first 7 to 15 days that the potatoes are in storage are critical to healing skin damaged during harvest and handling. This process is similar to the post-dehaulming time to enhance the health of the potato skin.

1. *Cooling*. The storage doors should be opened at night and closed during the day. The purpose is to allow cool air to enter the doors at ground level and warm air to leave the upper doors as it rises.
2. *Targets*. Potato curing can occur when temperatures are in the range of 5°C to 20°C. The temperature achieved in the storage depends on outside air temperatures, but keeping the cool air inside during the day is important. Humidity should be at least 85% for best curing. The process should be completed in one to two weeks.
3. *Do not disturb*. During the curing period potatoes should not be handled. An exceptions would be if part of the crop needs to be marketed earlier than expected due to quality problems, market opportunities or financial concerns.

Storing

Growers should focus on marketing opportunities during the storage season. The best rprices are not always at the end of the storage season. Growers should continually care for their stored potatoes by doing the following.

1. *Monitor*. Someone on the farm should take responsibility for storage management. That includes continual monitoring of temperature and humidity in the storage. Changes could mean that potatoes should be marketed soon. Potato buyers may ask to see the temperatures and humidity ifformation.
2. *Open/close doors*. The storage doors should be opened at night and closed during the day just like during the curing period.
3. *Add humidity*. If the humidity falls below 85% water can be added to the air in the storage several ways. A pan of water could be placed by the air inlet doors. Wet blankets or ropes could be placed inside the storage and re-moisturized as the dry out.

Discussion

Desired Impact

Progress toward the long-term storage goals could have the following impacts.

1. *More storage capacity.* As growers become aware of the costs and benefits of storage, the total capacity to store potatoes in Kenya could increase.
2. *Losses reduced.* Educational programs regarding potato storage could reduce the amount of post-harvest losses due to inadequate facilities or knowledge.
3. *Market access.* Increased storage capacity could increase market opportunites for individual grweors or groups of growers. Potato buyers are interested in suppliers who can provide product over a long marketing season.
4. *Higher prices.* There could be two positive price impacts for growers who are successful at storage. First, prices are higher during the dry season. Second, grower may get an above-market price premium for high-quality potatoes coming out of storage.
5. *Stable prices.* Storage allows for a more orderly flow of product to market. The impact could be less volatility in prices and there for less price risk.
6. *Availability.* Growers or groups of growers with storage could become year-round supplies of potatoes. This could attract more buyers, increase prices and provide a source of revenue all year.

Source of storage advice

One of the keys to success is the education of growers about storage costs, benefits and opportunities. Nancy Ng'ang'a of KARI found that parents were to top source of advice on ware storage (Table 4). The second-rated for source for Nyandarua growers was "farmers from other areas." In Meru it was the Ministry of Agriculture.

Nancy's surveys also asked growers to rate the best source of advice for ware potato storage (Table 5). She found that over 60% of the respondents in both counties gave "no one" as an answer. That suggests two things. First, growers don't enough about storage to know whom to trust. Second, there is an identified need for some organization to provide a much needed educational program on a very important potato marketing issue – storage.

Economics of storage

Preliminary analysis of the economics of storage in a facility like the one shown at the December 2012 Kasima Field Day, are positive. Estimated construction costs for the facility designed to hold 150 bags of 110 kg each is 188,172 shillings. Those costs include a charge for labor even though it may be provided by the farm family. The estimate also assumes that all materials are purchased rather than supplied by the farmer. A price increase of 1200 per bag shillings

would increase revenue by 180,000 shillings, almost covering the entire construction cost with one crop.

A relevant economic issue also beyond the scope of this project is agricultural financing. With adequate storage facilities and storage management expertise growers would have collateral for loans or advances from purchasers. This is an additional benefit that could be possible.

Sprout Suppressant

Research by Dr Kabira showed that chemical sprout suppressant can be an effective storage management tool in Kenya. Use of sprout suppressants is not on the list of recommended practices for three reasons. First, I assumed that growers who follow my recommended practices would be able to store potatoes for the two to three month gaps between crops without sprout suppressant. Second, there are some health concerns about CIPC, the main chemical sprout suppressant. For example, Japan will not accept potatoes that have been treated with CIPC. Third, sprout suppressant would be an additional cost that might not provide enough additional revenue to cover that cost.

Tables

Table 1. Advantages and disadvantages of storage types

Type	Advantages	Disadvantages
In Field	Inexpensive	Monitoring difficult
	No handling	Pest control
		Next crop preparation
		Theft
Clamp	Inexpensive	Monitoring difficult
	Local materials	Pest control
		Wet during rains
Multi-purpose	Available	Rapid quality loss
	Sunk cost	Greening risk
		Short term only
Ambient	Electricity not needed	Requires capital
	Control T, hum, air, light	Education needed
	Use local materials	
Powered	Control T, hum, air, light	Requires power
	Longer storage	Education needed
	Possible wind power	
Cold Storage	Longest storage	Requires power
	Market flexibility	Very expensive
	Automatic controls	

Table 2. Types of storage used by ware growers

Type	Nyandarua	Meru
Dark store	45%	45%
Diffused light store	0%	0%
Dark room	8%	13%
In lighted store in gunny/sisal bags	29%	28%
In lighted store in nylon bags	0%	1%
In a heap inside a lighted store	10%	11%
Covered in heap inside a lighted store	4%	1%
Covered with grass in dark store	5%	0%

Source: Nancy Ng'ang'a, KARI

Table 3. Share of growers who dehaulm

County	Portion
Kiambu	7%
Nyandarua	23%
Meru	28%
Nakuru	26%

Source: Nancy Ng'ang'a, KARI

Table 4. Sources growers used for advice regarding storage

Source	Nyandarua	Meru
Neighbouring farmer	13%	12%
Farmer from other area	20%	9%
Parents	33%	28%
Family members	6%	16%
Ministry of agriculture	1%	18%
Seed stockist	1%	0%
KARI/KEPHIS	1%	1%
CBOs	1%	0%
Combination of sources	23%	16%

Source: Nancy Ng'ang'a, KARI

Table 5. Grower rating of best source for advice regarding storage

Source	Nyandarua	Meru
No one	64%	65%
Neighbouring farmer	0%	1%
Farmer from other area	13%	6%
Parents	1%	5%
Family members	10%	16%
Potato broker	3%	0%
Ministry of agriculture	4%	5%
KARI/KEPHIS	3%	0%
CBO	0%	1%
own experience	0%	1%
Media	4%	0%

Source: Nancy Ng'ang'a, KARI